

THE INVESTIGATION OF PERFORMANCE & EMISSION CHARACTERISTICS OF DIESEL ENGINE BY DUAL FUEL (BIO DIESEL + BIO GAS)

R. SASIKUMAR¹ & G. SANKARANARAYANAN²

¹Research Scholar, Sathyabama Institute of Science and Technology Chennai, Tamil Nadu, India

²Professor, Sathyabama Institute of Science and Technology Chennai, Tamil Nadu, India

ABSTRACT

The examinations have been centered around finding the fuel that would be versatile to the current engine developments and that would meet the criteria in regards to sustainability, environment and unwavering quality of utilization. Satisfaction of the referenced criteria is the reason for an effective petroleum product substitution by some different kinds of fuel. Amid the most recent decade biodiesel has turned into the most widely recognized inexhaustible fluid fuel these days; creation of biodiesel from organic product seed oil is increasing more regard for supplant diesel fuel. Biodiesel, a clean inexhaustible fuel, has as of late been considered as the best for a diesel fuel substitution since it very well may be utilized in any pressure start engine with no adjustment. The principle target of this work is to examine the effect of biodiesel from Prosopis Juliflora oil on performance and examination qualities with bio-diesel. In this examination, the impact of bio-diesel from Prosopis Juliflora oil and its mixes on a solitary chamber Kirloskar TV-1 diesel engine were explored. In this work, the performance and examination investigation were led. The tests were performed at enduring state conditions with Prosopis Juliflora bio-diesel with various extent territory from 25 to 100% in ventures of 25 (Sample 1, Sample 2, Sample 3, Sample 4 and Sample 5). In two mixes B 25 and B50 the point of this examination was to reformulate the fuel to use the biodiesel and its mix to improve the energizes performance, trademark and to decrease the contamination from the engine. The test results uncover a minimal diminishing in brake warm productivity when contrasted with that of sole fuel. In this examination, the examination test were with the assistance of the AVL DI gas analyser, in which CO, HC and smoke density are minimal expanded then again CO₂, O₂ and NO_x are considerably decreased when contrasted with that of sole fuel.

KEYWORDS: Prosopis Juliflora Oil, Transesterification, Biodiesel, Biogas, Oxides of Nitrogen & Smoke

Received: Feb 11, 2019; **Accepted:** Mar 01, 2019; **Published:** Mar 29, 2019; **Paper Id.:** IJMPERDAPR201973

INTRODUCTION

Energy is a basic and indispensable contribution for monetary action. Building a strong base of energy assets is a pre-imperative for the supportable financial and social advancement of a nation. Aimless extraction and expanded utilization of petroleum derivatives have prompted the decrease in underground based carbon assets. Energy emergency because of quick exhaustion of non-renewable energy source and ecological air contamination because of petroleum product burning are of disturbing concerns around the world. Exponentially expanding populace, fast development of industrialization and the worldwide pattern of urbanization have completely exasperates the eco-balance and the parity of assets on earth.

Indian economy and advancement endure definitely because of the consistently developing unrefined petroleum import and the extreme worldwide danger presented by expanding non-renewable energy source ignition

emissions. Researchers and specialists are compelled to focus on finding a sustainable, and condition cordial substitute wellspring of energy. Prosopis Juliflora, a tree-borne oil seed is a promising wellspring of bio fuel to enhance our future energy prerequisite and to decrease the natural debasement through its biodiesel and biogas applications.

OBJECTIVE AND METHODOLOGY

Objective

- The target of the present examination is to assess the diverse level of bio-diesel with diesel mixes in CI engine
- Prosopis Juliflora is utilized as bio-diesel in this work.
- To examine the security, mixable and non – partition of the fuel mixes.
- To break down the physical and synthetic properties of bio – diesel mix.

METHODOLOGY

- In this examination, the impacts of bio– diesel mix with diesel on a CI Engine were explored.
- In this work, the performance and examination investigation were led in a CI Engine.

The volumetric rates of bio-diesel mixes with diesel are in the proportion of B25 and B50, these speak to the proportions of bio-diesel sum in the absolute mix and the rest diesel.

Table 1: Sample Volumetric Composition

Number	Bio –Diesel + BIO Gas	Bio –Diesel + BIO Gas
	Batch 1	Batch 2
Sample 1	B 25 + BG 10%	B 50 + BG 10%
Sample 2	B 25 + BG 20%	B 50 + BG 20%
Sample 3	B 25 + BG 30%	B 50 + BG 30%
Sample 4	B 25 + BG 40%	B 50 + BG 40%
Sample 5	B 25 + BG 50%	B 50 + BG 50%

Methodology – Experimental Analysis

- The engine was coupled to an eddy current dynamometer for the load to measurement.
- HC, CO₂, CO, NO_x were measured by utilizing AVL Di – gas analyzer.
- Smoke was measured by utilizing AVL smoke meter.
- The tests were performed at various loads, the engine was permitted to keep running with diesel at variable loads of 20%, 40%, 60%, 80% and 100% at an appraised speed of 1500 rpm with full load of 5.2 kW.
- Controlling pollution, we are added Catalytic converter & Heat exchanger.
- After finishing the experiment with diesel, the investigation was directed with Sample 1, Sample 2, Sample 3, Sample 4 and Sample 5 pollution

Experimental Investigation on Biogas Generation

Moderation of green house gas discharges through sustainable power source generation is of expanding significance. Biogas generation is a key innovation for the manageable utilization of agrarian biomass. Usage of biogas has

picked up significance as of late because of its sustainable, ecological good and cloud nature. Further, with an expansion in the expense of oil based commodities, biogas can be a compelling alternative source of energy for cooking, lighting, nourishment preparing, water system, rural electrification, and a few different necessities.

Anaerobic digestion has been utilized for a long time to treat strong natural wastes, fundamentally of local beginning. Digestion appeared a conceivable technique for diminishing the contamination brought about by farm slurries and furthermore to be a method by contamination control, which could give energy. Biogas innovation contributes the following.

- It gives a superior and less expensive fuel for cooking, lighting, and power age.
- It gives great quality, enhanced fertilizer to improve soil fertility.
- It gives a powerful and advantageous path for clean transfer.
- It produces social advantages, for example, diminishing weight on woodland for fuel wood, decrease in the drudgery of ladies and kids and so forth.
- As a smokeless local fuel it lessens the rate of eye and lung diseases.

Biogas plants can be characterized in a few different ways relying on the structure and method of activity. One regular method for order into arranges these as movable drum type and fixed arch type. The plants can likewise be delegated batch type, semi nonstop and continuous fed type. Inbatch type digester gives less average gas production and has high hydraulic residence time (HRT). It is suitable for crop and forest wastes, agro-industrial wastes and the same has been considered in the present work.

The de-oiled cakes have been customarily utilized as a compost meet the prerequisites of the dirt. The de-oiled cake of *Prosopis Juliflora*, staying after the extraction of oil from the seeds is wealthy in carbon and hydrogen substance and has no specific incentive as a manure, however can possibly yield biogas. The goal of the present test work is to research the anaerobic treatability and methane age capability of the de-oiled cake of *Prosopis Juliflora* by performing biochemical methane potential (BMP) test in a cluster type digester without arrangement to control the parameters influencing biogas age. Likewise, the work incorporates the investigation of the variety of various parameters that influence the anaerobic processing, for example, pH, biochemical oxygen request (BOD), chemical oxygen request (COD), alkali nitrogen and complete nitrogen amid the different phases of biogas age.

EXPERIMENTAL SET UP

The exploratory set up comprises of a digester with a stirrer and a provision to gather and measure the amount of biogas generated during the anaerobic digestion process. The schematic representation of the test set up is appeared in Figure 1.

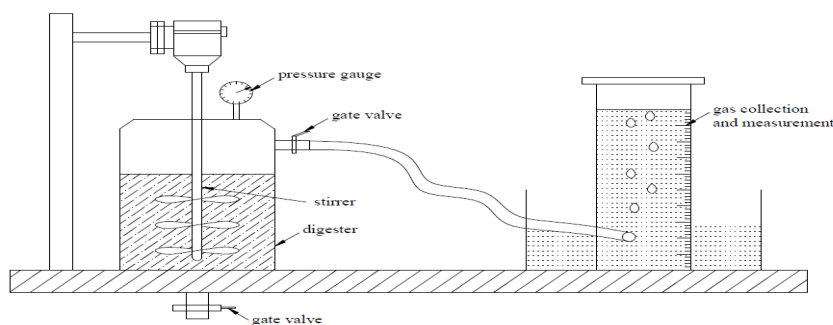


Figure 1: The Schematic Representation of the Test set up for Bio Gas

Identification of Non Edible Oil

For this investigation work Prosopis Juliflora bio-diesel has been chosen as the alternate fuel Biodiesel prepared from Prosopis Juliflora oil is a potential option for being utilized as a fuel in CI engine. The length of the carbon chain or Prosopis Juliflora oil is as often as possible more prominent than that of general vegetable oil, which are basically made out of palamitic corrosive, oleic corrosive and linoleic corrosive. Biodiesel with bigger centane number may cause the improvement of diesel engine performance and a decrease of toxin emissions. Despite the fact that there is incredible potential for the utilization of Prosopis Juliflora biodiesel as transportation fuel or as a power source, examination into the fuel properties of Prosopis Juliflora biodiesel is somewhat constrained.

Preparation of Biodiesel

Prosopis Juliflora seed has been bought from the nearby market. Biodiesel is set up from Prosopis Juliflora oil by transesterification process. "Alcohol blend" is delivered by blending 200ml of methanol with 18grams of Potassium Hydroxide (KOH) Raw. Prosopis Juliflora oil is warmed. At the point when the temperature reaches around 600C "Alcohol blend" is added to the crude oil. At that point temperature is kept up at around 650C and the blend is mixed for about 30 minutes. Chemical response occurred and biodiesel got yielded. The resultant item contained biodiesel and Glycerol. The items were permitted to settle down in a reversed measuring utensil. Detachment occurred and glycerol which is heavier got settled down at the base, Glycerol was expelled and unadulterated biodiesel was gathered.

Table 1: Properties of Diesel and Biodiesel

Sample Name	Specific Gravity	Density Kg/m ³	Calorific Values kJ / kg
Diesel	0.823	823	44,710.66
B 25	0.843	843	42,955.13
B 50	0.850	850	40,364.76

Experimental Setup

The examination was done in Kirloskar TV I Engine. The eddy current dynamometer is combined with the engine and is utilized to load the equivalent, AVL Di - gas analyzer, AVL smoke meter and AVL burning analyzer are associated with the engine reasonably. The engine was permitted to run utilizing diesel at different rates of loads (20%, 40%, 60%, 80% and 100%). At every level of load readings identified with fuel utilization, smoke density, CO₂, O₂, CO, NO_x, HC and EGT were recorded. A similar procedure is repeated with different mixes of biodiesel (Sample 1, Sample 2, Sample 3 Sample 4 and Sample 5). With each mix the engine is kept running at different rates of loads (20%, 40%, 60%, 80% and

100%). At each load readings relating to performance and discharge attributes are recorded. The after effects of these trials are dissected and talked about in the forthcoming chapters.

Table 2: Test Engine Specification for (Kirloskar TV-1)

Type	Vertical, Water Cooled, Four Stroke
Number of cylinder	One
Bore	87.5 mm
Stroke	110 mm
Compression ratio	17.5:1
Maximum power	5.2 kW
Speed	1500 rev/min
Dynamometer	Eddy current
Injection timing	23° before TDC
Injection Pressure	220kg/cm ²

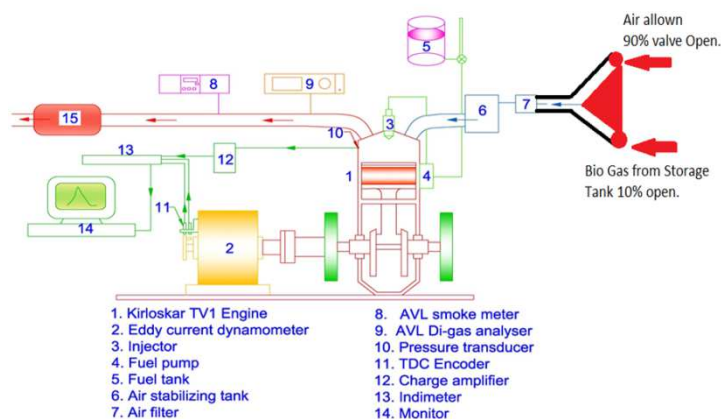


Figure 2: Experimental Setup

DISCUSSION OF RESULT

In the present work, the performance and emission tests were directed on diesel engine in double fuel mode for example Bio-Diesel(BD)as essential fuel and Bio-gas (BG) at 10%, 20%, 30%, 40% and 50% as auxiliary fuel individually. [10]. The fuel terms are signified as B 25+ BG 10%, B 25+ BG 20%, B 25 + BG 30%, B 25 + BG 40%, and B 25 + BG 50%, B 50 + BG 10%, B 50 + BG 20%, B 50 + BG 30%, B 50 + BG 40%, and B50+BG 50%, where the mass stream rates of Bio-gas in showed after BG. The consequences of the performance and emission test are portrayed underneath. The performance test results are talked about in the consequent area. The engine performance with Bio-diesel fuel (BD)and Bio-gas (BG) was assessed as far as brake thermal efficiency(BTE), brake specific Fuel consumption (SFC) and exhaust gas temperature (EGT) at no load, 1.04 KW, 2.08KW, 3.12 KW, 4.16 KW and 5.2 of brake power[11].

Brake Thermal Efficiency

The variety between brake thermal efficiency and brake power for Bio-Diesel and Bio-gas on double fuel activity is outlined in Figure 3 & 4. An extensive decrease in brake thermal efficiency is seen in double fuel mode when contrasted with that of BD mode at all loads. The most extreme efficiency accomplished by Diesel was 27.5% though in double fuel mode, greatest effectiveness accomplished was for Sample 1 B 25 + BG 10%, B 25 + BG 20%, B 25 + BG 30%, B 25 + BG 40%, B 25 + BG half, at that point comparatively Sample 2 B 50 + BG 10%, B 50 + BG 20%, B 50 + BG 30%, B 50 + BG 40%, B 50 + BG half, individually. The decrease in BTE is because of the lower calorific value of Bio-gas, which

contains more combusted blend that goes into the engine. Bio-gas advanced from the engine is at higher temperature and consequently density of Bio-gas is diminished, which thusly decreases the mass stream rate of Bio-gas and air required for burning, bringing about bringing down the oxygen level required for ignition. This lacking oxygen in the burning chamber is the reason for incomplete combustion [12].

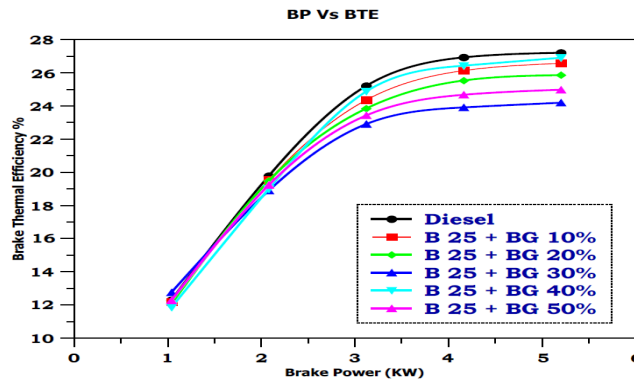


Figure 3: Brake Power Effect of on Brake Thermal Efficiency in Double Fuel Mode

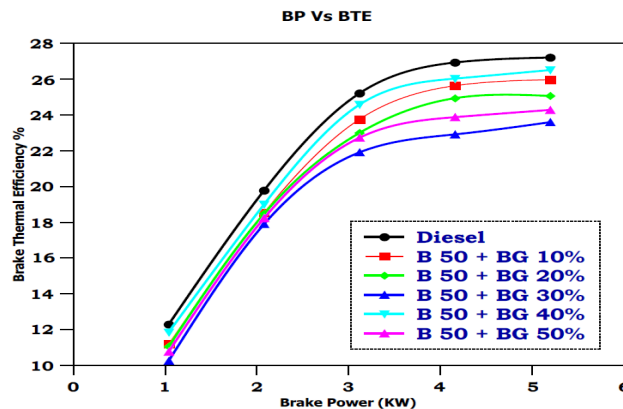


Figure 4: Brake Power Effect of Brake Thermal Efficiency in Double Fuel Mode

Exhaust Gas Temperature (EGT):

The variety of exhaust gas temperature with brake power for Diesel and Bio-gas on double fuel task is depicted in Figure 5 & 6. The exhaust gas temperature of Diesel at full load is observed to be 330°C while the exhaust gas temperature at full load for Sample 1 B 25 + BG 10%, B 25 + BG 20%, B 25 + BG 30%, B 25 + BG 40%, B 25 + BG 50%, at that point also Sample 2 B 50 + BG 10%, B 50 + BG 20%, B 50 + BG 30%, B 50 + BG 40%, B 50 + BG 50%, individually. It very well may be seen from the assumed that the exhaust gas temperature in double fuel mode is constantly higher than Diesel. This is because of the overabundance vitality provided to the engine [13]. The exhaust gas temperature can be diminished by expanding the density of fuel blend for combustion in the engine.

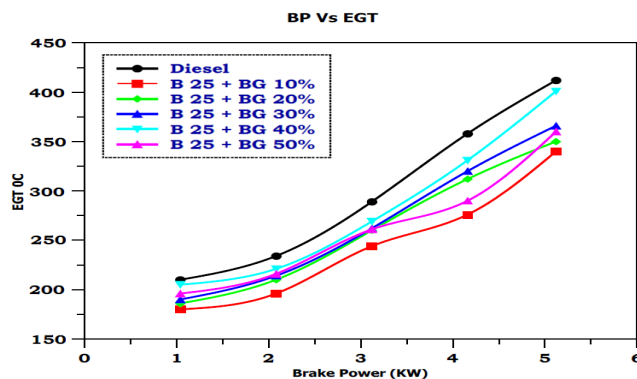


Figure 5: Brake Power Effect of Exhaust Gas Temperature in Dual Fuel Mode

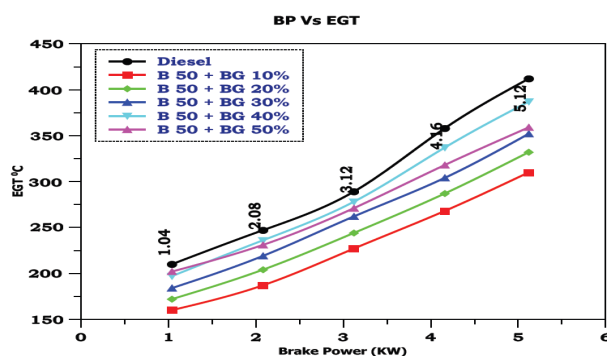


Figure 6: Brake Power Effect of Exhaust Gas Temperature in Dual Fuel Mode

Emission Characteristics of Diesel Engine in Double Fuel Mode

Emission from the engine reflects the nature of combustion takes place inside the engine. The different discharge emission estimated during diesel and double fuel (B 25 + BG) and (B50 + BG) mode activity are talked about as pursues.

Carbon Monoxide (CO) Emission

The variety of unburnt hydrocarbon emission of the engine with Diesel and double fuel is delineated. Unburnt hydrocarbon emissions are the immediate after effect of fragmented ignition. It tends to be seen from the assume that the unburnt hydrocarbon emission is the most reduced for diesel while it is the most astounding for Diesel with Bio-gas with mass stream rate of 80% in double fuel mode. Likewise, the unburnt hydrocarbon emission in all double fuel mode activity in this investigation is higher than diesel operation. As consequence of the supplanted Bio-gas in the drafted air, more hydrocarbon discharge is shaped in double fuel mode. Be that as it may, the estimations of unburnt hydrocarbon for all the tried powers in various mode in this examination lie below 25ppm as it were.

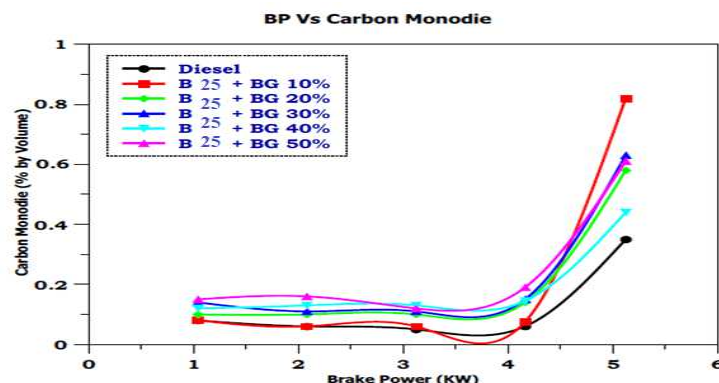


Figure 7: Brake Power Effect of Carbon Monoxide in Dual Fuel Mode

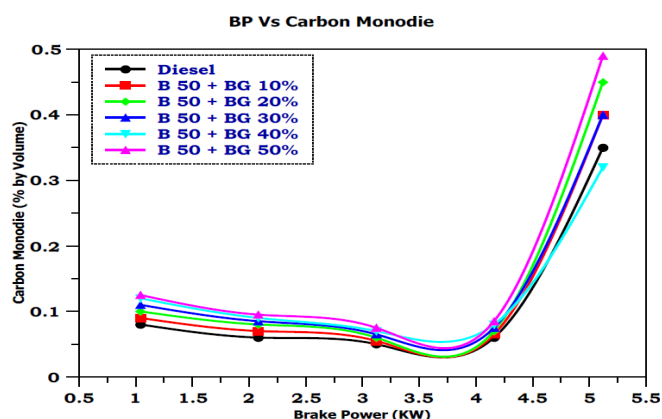


Figure 8: Brake Power Effect of Carbon Monoxide in Dual Fuel Mode

Nitrous Oxide (NO) Emission

Higher temperature and accessibility of oxygen are the two primary reasons behind the development of oxides of nitrogen (NO_x) in compression ignition engines. Nitrogen is inert at low temperature, however at temperature higher than 1100°C nitrogen reacts with oxygen and structure oxides of nitrogen [16]. From Figure 9 & 10, it tends to be seen that the NO emission increments with expanding load for every one of the fills for example Bio-Diesel and BD + BG fuel. This is because of the high temperature in burning chamber acquired at expanded load. At low loads, unimportant distinction in NO emission is watched while working the engine on diesel and double fuel mode. As the load expands the variety of NO discharge increments among Diesel and (B 25 + BG) and (B 50 + BG) fuel. NO emission is observed to be higher in diesel activity than that of double fuel mode. Additionally natural nitrogen from the air causes NO_x development. Bio-gas don't have natural nitrogen, it has just air nitrogen, which inorganic nitrogen [17].

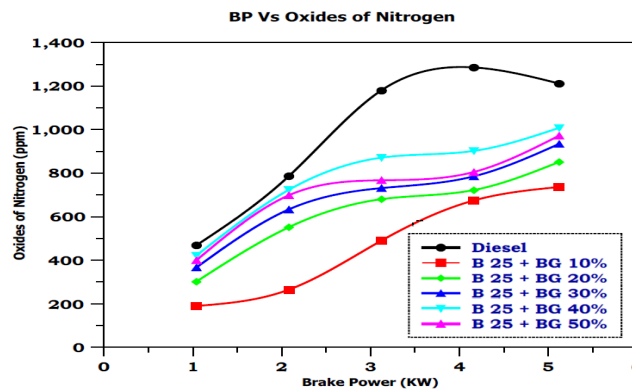


Figure 9: Brake Power Effect of Nitrous Oxide in Dual Fuel Mode

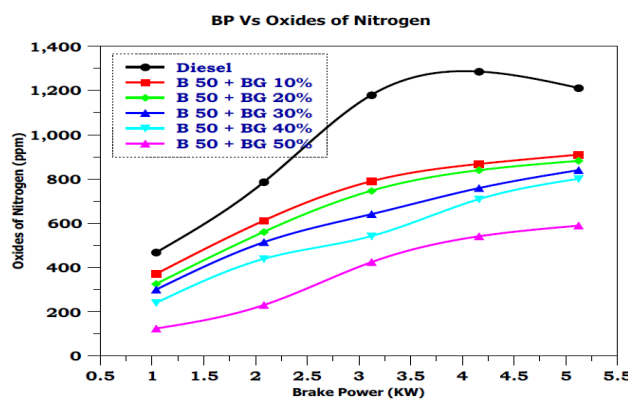


Figure 10: Brake Power Effect of Nitrous Oxide in Dual Fuel Mode

Smoke Density

The reason for smoke is incomplete combustion which might be because of inaccurate air-fuel proportion or might be because of ill-advised blending of fuel with air. As appeared in Figure 11 & 12, significant difference is seen between smoke density of different fuels at no load and full load, however the change was exceptionally immaterial at low load of the engine. In double fuel method of activity, the smoke density is seen to be higher than that of the Diesel fuel for all mix of BG. In diesel task, the smoke density achieved a most extreme estimation of 25% where as it is observed to be 32% in double fuel mode for B 25 + BG 30% at full load.

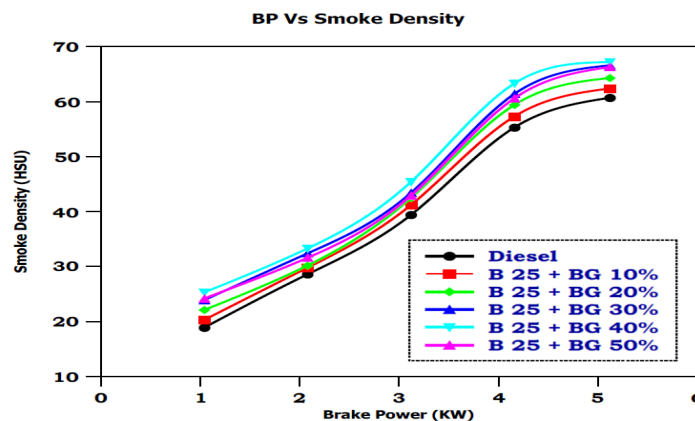


Figure 11: Brake Power Effect of Smoke Density in Dual Fuel Mode

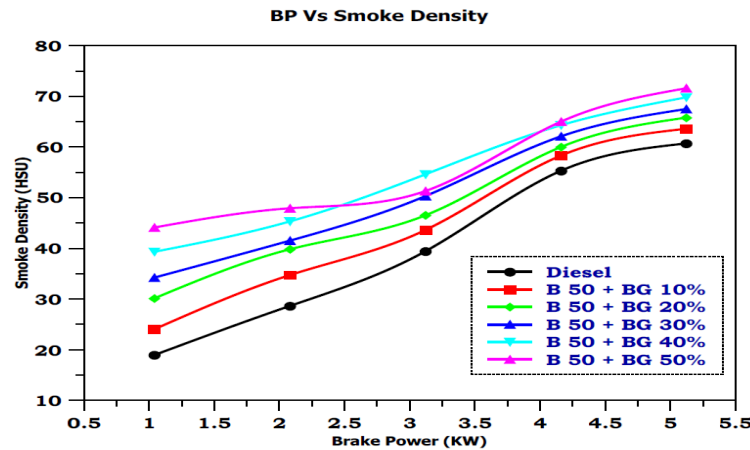


Figure 12: Brake Power Effect of Smoke Density in Dual Fuel Mode

CONCLUSIONS

The performance and exhaust emission qualities are examined tentatively in a single cylinder, 4-stroke, water-cooled DI diesel engine working on a double fuel mode and following ends are made based on trial outcomes.

- Bio-Diesel fuel can be spared by supplanting diesel with Bio-gas. Despite the fact that, amid the trial there is 5.45% decrease in brake thermal efficiency for the ideal estimation of double fuel activity with B25 + BG40% at full load in examination with diesel fuel, which is because of lower heating estimation of Bio-gas.
- NO emission is diminished by 18.70% with double fuel activity of B 25 + BG40% at full load in examination with diesel, which is an extraordinary favourable position of double fuel mode over diesel fuel alone.
- Dual fuel operation with B 25 + BG40% increments both CO and HC outflows up to 17.40% and 15.39% separately at full load in correlation with diesel, which gives a sign of lacking oxygen in burning chamber. By and large, it tends to be reasoned that the double fuel tasks of double fuel with B25 + BG40% gives improved engine performance and lower tail pipe outflows contrasted and other Bio-gas stream rates.

REFERENCES

1. G. N. Tiwari and M. K. Ghosal, *Fundamentals of Renewable Energy Sources: Basic Principles and Applications*. Narosa Publishing House, New Delhi, 2007.
2. Juan, J, Hernandez., Guadalupe Aranda-Almsnsa, Bula, A., 2010. Gasification of biomass wastes in an entrained flow gasifier; effect of the particle size and the residence time 91(6), pp. 681-692
3. Stassen, H. E. M., Knoef, H. A. M., 1993. Small scale gasification systems, The Netherlands: Biomass Technology Group, University of Twente. McKendry, P. Energy production from biomass (part 3): gasification technologies. *Journal of Bioresource Technology* 2002; 83: 55-63.
4. Bridgwater, A. V., Evans, G. D. An Assessment of Thermochemical Conversion Systems for Processing Biomass and Refuse. Harwell Laboratory, Energy Technology Support Unit: ETSU B/T1/00207/REP; 1993. Volli, V., Singh, R. K., 2012. Production of bio-oil from de-oiled cakes by thermal pyrolysis, NIT Rourkela, India.
5. Abdullah, S. B., Man, Z., Ismail, L., Maulud, A., & Bustam, M. A. (2013). Ionic liquids classification for fuel desulphurization. *Int. J. Gen. Eng. Technol*, 2, 29-38.

6. Lin C. L., Wey M. L. and You S. D., The effect of particle size distribution on minimum fluidization velocity at high temperature, *power technol.*,126,297-301(2002)
7. Roy, M. M., Tomita, E., Kawahara, N., Harad, Y., Sakane, A., 2009. Performance and emission comparison of a supercharged dual-fuel engine fuelled by producer gases with varying hydrogen content.
8. Das, D. K., Dash, S. P., Ghosal, M. K., 2011. Performance Study of a Diesel Engine by using producer gas from Selected Agricultural Residues on Dual-Fuel Mode of Diesel-cum-Producer gas.
9. Deshmukh, Samir J., Bhuyar, Lalit B., Thakre, Shashank B., 2008. Investigation on Performance and Emission Characteristics of CI Engine Fuelled with Producer Gas and Esters of Hingan (Balanites) Oil in Dual Fuel Mode.
10. Hassan, S., Mohd Nor, F., Zainal, Z. A., Miskam, M. A., 2011. Performance and emission characteristics of supercharged Biomass producer gas-diesel dual fuel engine.
11. Mathur, M. L., Sharma, R. P., 2006. Internal combustion engine, Dhanpatrai publication, p. 738.
12. Umesh, K. S., Pravin, V. K., & Rajagopal, K. (2014). Experimental Investigation and CFD Analysis of Multi-Cylinder Four Stroke SI Engine Exhaust Manifold for Optimal Geometry to Reduce Back Pressure and to Improve Fuel Efficiency. *International Journal of Automobile Engineering Research and Development*, 4, 13-20.
13. Singh, R. N., Singh, S. P., Pathak, B. S., 2007. "Investigations on operation of CI engine using producer gas and rice bran oil in mixed fuel mode." *Renewable Energy*
14. Vinay Shrivastava, Abhishekh Kumar Jha, Arun Kumar Wamankar, S. Murugan 2013. "Performance and Emission Studies of a CI Engine Coupled with Gasifier Running in Dual Fuel Mode" *Procedia Engineering* 51, pp. 600 – 608.

